

Amendments to the Claims

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims

1-28. (Canceled)

29. (Previously Presented) A method of forming a fuel cell, comprising the steps of:

providing a first electrode layer having a first surface and a second opposing surface, wherein at least a portion of the first surface is conductive;

forming a first aperture defined by a first aperture surface through the first electrode layer;

providing a second electrode layer having a first surface and a second opposing surface, wherein at least a portion of the first surface is conductive;

forming a second aperture defined by a second aperture surface through the second electrode layer;

providing a proton exchange membrane having a first surface and a second opposing surface;

providing a conductive adhesive between the first electrode layer and the proton exchange membrane and between the second electrode layer and the proton exchange membrane;

sandwiching the proton exchange membrane and the adhesive between the first electrode layer and the second electrode layer with the first and second apertures substantially free of the adhesive, where the first aperture of the first electrode layer is at least partially aligned with the second aperture of the second electrode layer, thereby exposing the proton exchange membrane, wherein the second surface of the first electrode layer is proximate the first surface of the proton exchange membrane and the

first surface of the second electrode layer is proximate the second surface of the proton exchange membrane;

providing an electrical connection between at least a portion of the first surface that is conductive of the first electrode layer and the proton exchange membrane; and

providing an electrical connection between at least a portion of the first surface that is conductive of the second electrode layer and the proton exchange membrane.

30. (Previously Presented) A method according to claim 29 wherein the proton exchange membrane includes a catalyst.

31. (Previously Presented) A method according to claim 30 wherein the proton exchange membrane includes a perfluorosulfuric acid membrane with a polytetrafluoroethylene backbone.

32. (Previously Presented) A method according to claim 30 wherein the catalyst includes carbon/platinum.

33. (Previously Presented) A method according to claim 29 wherein at least a portion of the second surface of the first electrode layer is conductive and in electrical contact with a conductive portion of the first surface of the first electrode layer.

34. (Previously Presented) A method according to claim 29 wherein at least a portion of the second surface of the second electrode layer is conductive and in electrical contact with a conductive portion of the first surface of the second electrode layer.

35. (Canceled)

36. (Previously Presented) A method according to claim 29, wherein the step of providing the first electrode layer includes providing a conductive layer on at least a portion of the first surface of the first electrode layer.

37. (Previously Presented) A method according to claim 36, wherein the first electrode layer is substantially non-conductive prior to providing the conductive layer.

38. (Canceled)

39. (Previously Presented) A method according to claim 37 wherein the conductive layer covers at least part of the first aperture surface.

40. (Previously Presented) A method according to claim 37 wherein the conductive layer on the first electrode layer extends from the first surface of the first electrode layer to the second surface of the first electrode layer along the first aperture surface of the first aperture.

41. (Previously Presented) A method according to claim 29 wherein the step of providing the second electrode layer includes providing a conductive layer on at least a portion of the first surface of the second electrode layer, and wherein the conductive layer on the second electrode layer extends from the first surface of the second electrode layer to the second surface of the second electrode layer along the second aperture surface of the second aperture.

42. (Previously Presented) A method according to claim 29 wherein the first electrode layer is conductive.

43. (Previously Presented) A method according to claim 29 wherein the second electrode layer is conductive.

44. (Previously Presented) A method according to claim 29 wherein the first electrode layer is substantially non-conductive, and includes one or more conductive through contacts.

45. (Previously Presented) A method according to claim 29 wherein the second electrode layer is substantially non-conductive, and includes one or more conductive through contacts.

46. (Cancel)

47. (Previously Presented) A fuel cell comprising:
a first electrode comprising:
a non-conductive substrate, the non-conductive substrate having a first electrode top surface, a first electrode bottom surface, and a first electrode thickness defined by a first distance between the first electrode top surface and the first electrode bottom surface;
a first electrode aperture through the first electrode thickness defined by a first electrode aperture surface;
a second electrode comprising:
a second electrode top surface;
a second electrode bottom surface;
a second electrode thickness defined by a second distance between the second electrode top surface and the second electrode bottom surface;
a second electrode aperture through the second electrode thickness defined by a second electrode aperture surface;
a first conductive layer provided on at least a portion of the first electrode top surface, at least a portion of the first electrode bottom surface, and one or more of at least a portion of the first electrode aperture surface and a through contact, wherein the first conductive layer on the one or more of the at least a portion of the first electrode aperture surface and the through contact provides an electrical connection between the first conductive layer on the first electrode top surface and the first conductive layer on the first electrode bottom surface;
a second conductive layer provided on at least a portion of the second electrode top surface;

a proton exchange membrane in electrical contact with and disposed between the first conductive layer and the second conductive layer;

wherein, the first electrode aperture is at least partially aligned with the second electrode aperture, thereby exposing the proton exchange membrane.

48. (Previously Presented) The fuel cell according to claim 47, wherein the proton exchange membrane includes a top catalyst layer and a bottom catalyst layer.

49. (Previously Presented) The fuel cell according to claim 47, wherein the proton exchange membrane has a thickness of 1 mil or less.

50. (Previously Presented) The fuel cell according to claim 47, wherein the first aperture surface defines a first aperture cross-sectional surface area of 1 mm² or less.

51. (Previously Presented) The fuel cell according to claim 47, wherein the first conductive layer has a thickness of 1000Å or less.

52. (Previously Presented) The fuel cell according to claim 47, wherein the second conductive layer having a thickness of 1000Å or less.

53. (Previously Presented) The fuel cell according to claim 47, wherein the first electrode thickness and the second electrode thickness are 2 mil or less.

54. (Previously Presented) A method of forming a plurality of fuel cells, comprising the steps of:

providing a first length of non-conductive material having a first plurality of apertures therethrough and a first plurality of electrical contacts, wherein the first plurality of electrical contacts include one or more conductive contacts that extend through the first length of non-conductive material;

providing a second length of material having a second plurality of apertures therethrough and a second plurality of electrical contacts that extend through the second length of material;

providing a proton exchange membrane;

providing an adhesive layer between the proton exchange membrane and the first length of material, between the proton exchange membrane and the second length of material, or between the proton exchange membrane and the first and second length of material;

laminating the proton exchange membrane and any adhesive between the first length of material and the second length of material, where the first plurality of apertures are at least partially in registration with the second plurality of apertures, and wherein at least part of the proton exchange membrane is aligned with the plurality of first and second apertures to form a plurality of fuel cells; and

providing a plurality of electrically conductive connections between the proton exchange membrane and each of the first and second pluralities of electrical contacts.

55. (Previously Presented) A method according to claim 54, further comprising the step of dicing the plurality of fuel cells into single fuel cells.

56. (Previously Presented) A method according to claim 54 wherein the first plurality of electrical contacts are positioned on a surface of the first length of material that is facing away from the proton exchange membrane.

57. (Canceled)

58. (Previously Presented) A method according to claim 54 wherein the second plurality of electrical contacts are positioned on a surface of the second length of material that is facing away from the proton exchange membrane.

59. (Previously Presented) A method according to claim 58 wherein the second plurality of electrical contacts include one or more conductive contacts that extend through the second length of non-conductive material.

60. (Previously Presented) A method according to claim 54 wherein the adhesive is conductive.

61. (Previously Presented) A method according to claim 29 wherein at least one of the steps of providing an adhesive between an electrode layer and the proton exchange membrane is replaced by a lamination step without adhesive.

62. (Previously Presented) A method according to claim 54 wherein the step of providing an adhesive between the proton exchange membrane and at least one of the first length of material and the second length of material is replaced by a lamination step without adhesive.

63. (Previously Presented) A method of forming a plurality of fuel cells, comprising the steps of:

providing a first length of non-conductive material having a first plurality of apertures therethrough and a first plurality of electrical contacts therethrough;

providing a second length of material having a second plurality of apertures therethrough and at least a second electrical contact;

providing a proton exchange membrane;

passing the first length of material, the proton exchange membrane, and the second length of material through a joining unit, wherein the proton exchange membrane is between the first length of material and the second length of material, the first plurality of apertures and the second plurality of apertures are at least partially aligned thereby exposing the proton exchange membrane therebetween, and the proton exchange membrane is in electrical contact with the first plurality of electrical contacts and the second electrical contact; and

laminating the first length of material, the proton exchange membrane, and the second length of material as they pass through the joining unit.

64. (Previously Presented) A method according to claim 63, wherein the proton exchange membrane includes a top catalyst layer and a bottom catalyst layer.

65. (Previously Presented) A method according to claim 63, wherein the second electrical contact through the second length of material comprises a plurality of electrical contacts.

66. (Previously Presented) A method according to claim 63, wherein laminating includes inserting an adhesive between at least one length of material and at least one of the proton exchange membrane and a second length of material.

67. (Previously Presented) A method according to claim 66, wherein the adhesive is conductive.

68. (Previously Presented) The fuel cell according to claim 47 further comprising a fuel reservoir in fluid communication with the proton exchange membrane.

69. (Previously Presented) The fuel cell according to claim 29 wherein at least one of the first electrode and the second electrode includes an insulating layer interposed between at least a portion of the first surface layer and the second surface layer.

70. (Previously Presented) The fuel cell according to claim 29 wherein the at least a portion of the first surface layer and the second surface layer of at least one of the first electrode and the second electrode comprise a single continuous material.